

Division of Chemistry and Chemical Technology  
NATIONAL ACADEMY OF SCIENCES—NATIONAL RESEARCH COUNCIL

FINAL REPORT  
Contract NASr-182

to  
Grants and Research Contracts  
Code SC  
Office of Space Sciences  
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION  
Washington, D. C. 20546

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## FINAL REPORT

CONTRACT NO. NASr-182

### SUMMARY

Information services relating to the prevention or limitation of environment-associated degradation of materials and equipment were provided to the National Aeronautics and Space Administration under Contract No. NASr-182. The contract provided partial support for the Prevention of Deterioration Center, an information center in this field of environmental and materials sciences, established and continued with primary support under a contract funded by the Army, Navy, and Air Force. The services provided to NASA included consultations on specific deterioration problems, abstracts of scientific and technical documents, bibliographies, document loans from the Prevention of Deterioration Center library and a state-of-the-art monograph related to the meteoroid environment. Another product of contract is a glossary of terms used in materials degradation studies in the hyperthermal environment.

### INTRODUCTION

Contract NASr-182 between the National Aeronautics and Space Administration and the National Academy of Sciences--National Research Council for partial support of the Prevention of Deterioration Center became effective January 1, 1964. This contract provided for information services, based on a large collection of scientific and technical literature, to be furnished NASA relating to the prevention of environment-associated deterioration of materials and equipment. The information services were provided in several forms including abstracts of scientific and technical reports, bibliographies, loans of documents, state-of-the-art monograph, a hyperthermal environment glossary, and consultations on specific degradation problems.

This report presents a summary of the work performed under the provisions of that contract. Throughout 1964 the services called for in the Statement of Work, Schedule Article I, were performed by the Prevention of Deterioration Center. The work performed under the provisions of this contract in 1965 was almost entirely related to preparation of the glossary called for in Schedule Article I.2. Loss of the major part of the financial support for the Prevention of Deterioration Center resulted in termination of the Center as a unit of the National Academy of Sciences--National Research Council in January 1965. However, the Division of Chemistry and Chemical Technology provided for the continuation of both the glossary work and limited document loan service from the collection that had been the PDC library.

## CONSULTING AND ADVISORY SERVICES

Consulting and advisory services were provided with the approval of NASA Contracting Officer as follows:

<u>Subject</u>	<u>Person and Establishment Served and Date</u>
Effects of UMDH fuel on space-craft materials, particularly optical equipment.	J. Farkas (Code 623) Goddard Space Flight Center Greenbelt, Maryland July 1964
Effects of radiation on materials and components of electrical and electronic circuits.	W. J. Bates, Project Director Trident Engineering Associates Inc. Annapolis, Maryland (Contractor to Goddard Space Flight Center) August 1964
Corrosion of underground distribution pipelines (including on-site survey of problem).	George L. Meidinger, Head Environmental Testing Support Section, and Percy J. Crain, Chief Engineering Technical Services Langley Research Center Hampton, Virginia September-November 1964
Acoustic noise problem in man-rated space simulation chamber during emergency re-pressurization.	G. A. Cosby, Project Manager Pittsburgh-DesMoines Steel Co. Pittsburgh, Pennsylvania October 1964
Titanium pressure vessels--compatibility with cryogenic liquids, impact sensitivity, and related hazards.	Mr. McSmith, Safety Officer NASA Langley Research Center Hampton, Virginia September 1965

## ABSTRACTING SERVICES

Abstracts of scientific and technical documents dealing with environment-related deterioration of materials and equipment were published by the Prevention of Deterioration Center in a monthly journal entitled "Environmental Effects on Materials and Equipment." The journal was published in two parts--Section A, dealing predominately with chemical, biological, and physical factors associated with terrestrial environments, and Section B, dealing predominately with the physical and engineering considerations of extreme thermal, mechanical (shock and vibration) and space-associated environments. Copies of these journals were provided to the NASA Scientific and Technical Information Division as well as to individual subscribers within NASA--twenty-nine subscribers for Section A, forty subscribers for Section B--including back issues to January 1960 upon request. This publication service was terminated on 31 May 1964 due to the loss of a major part of the PDC's financial support previously provided by the Army, Navy and Air Force.

## LIBRARY SERVICES

The library of the Prevention of Deterioration Center, containing approximately 70,000 titles, including a copy of the original document or report for each abstract published in the afore-mentioned journals, provided loan copies of documents to all requestors within the NASA, and to qualified NASA contractors. These loans were reported by item, indicating the individual requestors, in the quarterly status reports for 1964 and totaled 271 documents. During 1965, loans to the Librarian, Goddard Space Flight Center provided 33 documents.

## SPECIAL STUDIES AND BIBLIOGRAPHIES

Special studies and analyses of all available information, published and unpublished, were undertaken regarding the effects on materials and equipment of both the meteoroid and low temperature (-300F and below) environments encountered by space vehicle systems. A bibliography entitled "Interplanetary Debris", compiled by W. A. Cosby, was submitted to the NASA in September 1964 and included 344 titles with keyword descriptors as annotations to each entry. A state-of-the-art report, developed from the meteoroid environment study, was completed and has been published as NASA SP-78 "The Meteoroid Environment and its Effects on Materials and Equipment" by W. A. Cosby and R. G. Lyle. A similarly developed report based on the study of low temperature phenomena was terminated in an intermediate draft stage of completion because additional funding was not available to provide for continuation of this work beyond December 31, 1964.

Special studies conducted under the provisions of this contract also included literature searches and analyses in response to requests for documentation related to particular problems of environment-associated degradation of materials in the following cases:

<u>Subject</u>	<u>Requested By</u>
Cost analysis of preventive maintenance.	Librarian, John F. Kennedy Space Center
Handbooks and other instructions for dealing with radiation effects on materials, particularly electronic components and circuits.	A. H. Rice, Assistant Project Director Trident Engineering Associates, Inc., Annapolis, Maryland (Contractor to Goddard Space Flight Center)
Underground corrosion—causes and preventive techniques.	G. L. Meidinger, Head Environmental Testing Support Section Langley Research Center
Thermal degradation of polymeric adhesives; stress cracking in polymers; effect of humidity on dielectric breakdown across ceramic insulators.	C. H. Clatterbuck Goddard Space Flight Center Greenbelt, Maryland

#### GLOSSARY PROJECT

A project was formulated to accomplish the compiling of a glossary of terms and definitions used in hyperthermal environment studies of materials degradation, and was approved as to objectives and prescribed procedure by the NASA Project Officer. An extensive literature search and the review of approximately 600 documents were performed to develop candidate terms and definitions for consideration in the glossary work. More than 200 terms were selected for initial consideration. The plan for this project also called for a panel of persons, knowledgeable in related areas of technology, to provide criticism and indicate preferences regarding the terminology under review. A list of nominees for this advisory group was compiled with the cooperation of Mr. Frank Koubek, Chairman of Section III-L (Ablation), ASTM Committee D-20, and the NASA Project Officer. Invitations to participate in this project were sent out, and those who chose to cooperate in this effort became members of the Critical Review and Balloting Panel (see Appendix). The work with this group began with a critique of the list of candidate terms. This list was then revised and in August 1964, balloting of alternative definitions was begun.

A glossary of terms and definitions used in the technology relating to thermal protection as employed in the extreme environment of aerospace vehicle systems is submitted with this report. Those terms and phrases which the Critical Review Panel considered, are indicated by underscoring and have

definitions which were developed by carefully weighing the results of ballots and the critical comments and recommendations contributed by the members of that Panel.

When large differences among preferred definitions appeared in the results of balloting, revised alternatives were developed and second-round balloting was undertaken. In such cases, the panelists were also provided with a summary of the divergent opinions reflected in the first round of voting so that attention could be focused on the significant points of disagreement. In this way, a consensus regarding a suitable definition was achieved in practically all cases.

The definitions provided as alternatives in the ballots, were extracted from the literature concerning thermal protection systems, and existing technical glossaries. In many cases, due to the developing nature of the technology, these definitions were found to be out-dated or otherwise inadequate. These alternatives did, however, provide the Critical Review Panel with an indication of the confusion which existed. In many cases, members of the Panel responded with revisions to the alternatives or completely different definitions, which proved to be valuable to the glossary work. As the project moved along, there developed among the Panel members a more uniform propensity to present concepts in fundamental terms rather than by description of particular classes of applications of those concepts. This approach, of course, was necessary if the objective of this work was to be attained--that the glossary would present definitions that are both acceptable and useful to those working in the field. Furthermore, when definitions are developed so that they are not unduly biased toward particular classes of materials, components or environments, a significant obstacle to standardization of terminology is removed.

The development of this glossary, with the cooperation of the Critical Review and Balloting Panel, was almost entirely accomplished through written communications. A disadvantage of such extensive use of correspondence is the rather large time requirement that is involved when working with thirty-five or more participants. However, in the work of developing definitions, particularly when it is intended that the results will contribute to standardization in technical language, written communications are found to result in unhurried and careful formulation of critiques and recommendations by the participants. This is considered to be an important advantage over the alternative approach of employing frequent meetings of a committee for purposes of verbal deliberations.

Throughout the course of the glossary project, cooperative liaison was maintained with the American Society for Testing and Materials, Committee on Ablation. At the outset of this project, the Ablation group was identified with ASTM Committee D-20 on Plastics but more recently has been reorganized as Section 3, Subcommittee VI of ASTM Committee E-21 on Space Simulation. Approximately one-half of the members of the glossary project's Critical Review and Balloting Panel are, or have in the past, affiliated with the ASTM Committee on Ablation. The Chairman of Section 3, Subcommittee VI of ASTM Committee E-21 has been advised by the NASA Project Officer that the glossary developed in this project will be made available to the Committee.



## APPENDIX

### The Critical Review and Balloting Panel for Glossary Project of Contract No. NASr-182

The organizations and individuals listed below, contributed information and evaluations of terminology and definitions, which were essential inputs to the "Glossary of Terms in High Temperature, Thermal Protection Technology". These participants comprised a Critical Review and Balloting Panel for the glossary project involving terminology and definitions used in the technology of thermal protection systems as applied to aerospace vehicle systems. The definitions given for the underlined terms and phrases in the glossary were developed on the basis of: the preferences indicated by the panelists from among alternative definitions provided in a series of ballots; the modifications to the balloted definitions, recommended by the panelists; and definitions submitted by the panelists as preferred over those alternatives provided in the ballots.

Aerojet-General Corporation	William McLaughlin
American Instrument Company, Inc.	J. S. Lagarias
Atlantic Research Corporation	M. Markels, Jr.
Battelle Memorial Institute	E. W. Ungar
The Boeing Company, Aerospace Division Flight Technology Department	R. C. Miller
Chrysler Corporation	L. R. Biasell
Advanced Projects Organization	H. Roth
Defense-Space Group	F. A. Reid
Cornell Aeronautical Laboratory, Inc.	George Rudinger
General Dynamics/Fort Worth	W. H. Steurer R. A. Stevens
B. F. Goodrich Company Research Center	A. E. Juve E. Rowe
Grumman Aircraft Engineering Corporation	J. T. Graham L. G. Kaufman R. A. Oman
Hughes Aircraft Company Space Systems Division	R. W. Fehr

The John Hopkins University  
Applied Physics Laboratory

LTV Research Center

Martin Company

North American Aviation, Inc.  
Engineering Laboratory

North American Aviation, Inc.  
Rocketdyne Division

Philco Research Laboratories

Sandia Corporation

Space General Corporation

Thompson Ramo Wooldridge, Inc.

U. S. Polymeric Chemicals, Inc.

University of Dayton  
Research Institute

U. S. Army, Materials Research Agency  
Watertown Arsenal

U. S. Navy  
Naval Ordnance Laboratory

Naval Ordnance Tests Station

U. S. Air Force  
Flight Mechanics Division

Materials Laboratory

U. S. National Aeronautics and  
Space Administration  
Langley Research Center

G. L. Dugger  
R. A. Makofski  
N. G. Paul

J. Harkness

E. L. Strauss

C. J. MacMiller

S. Brelant  
R. S. Levine  
C. S. Lyons  
B. L. McFarland  
E. E. Fryk

S. R. Byron

H. R. Vaughn

S. L. Grindle

W. E. Winters

R. H. Reid

J. E. Minardi  
J. Wurst

A. P. Levitt

F. J. Koubek  
J. Raat

S. H. Herzog  
P. Hall  
H. B. Porter  
K. Okauchi  
W. K. Smith

M. L. Buck

D. L. Schmidt  
M. D. Jolly

C. M. Pittman  
I. E. Beckwith  
W. A. Brooks, Jr.  
J. C. Dunavant  
E. B. Prichard  
R. T. Swann